TAILORING THE PROPERTIES OF CVD DIAMOND FOR PASSIVE AND ACTIVE RADIATION APPLICATIONS

P. Ascarelli, E. Cappelli, D.M. Trucchi

CNR-ISC, Via Salaria km 29.300, 00016 - Monterotondo Scalo (RM), Italy

G. Conte

University of "Roma Tre", Dept. of Electronic Engineering, Via Vasca Navale, 84 - 00146 Rome, Italy

Keywords: CVD Diamond, conductivity, dosimeters, active applications.

Abstract

Diamond represents a paramount material for applications involving the use of radiations and electron beams of high-energy. In fact, due to a high radiation damage resistance and to the tissue-equivalent properties, coherently with wide band-gap properties, diamond is considered one of the most suitable material for the realization of x-ray detectors, especially for dosimetry in radiotherapy applications.

CVD diamond shows a polycrystalline structure in which the material quality largely influences the photoconductive response of the resulting detectors. The control of the material properties during the growth process and the optimal design of the final detector is the basis of the tailoring operation we performed.

The control of the initial nucleation density allows an actual engineering of the electrical properties of the diamond films. We developed a method to fix the device optimal leakage conductivity[1] as a function of the peculiar application. In fact, we found precise conditions about the electrical conductivity in order to contemporarily avoid space charge formation and to have sufficient discrimination of the signal.

At present, we realized x-ray linear dosimeters and tested them in DC and AC conditions using a beam produced by a standard Cu-target tube (CuKα at 8.05 keV). The analysis of the collection efficiency of the generated charge carriers and of the density of shallow states in the band-gap in proximity of the valence band, affecting the response time and intensity, were correlated with structural parameters as the crystal grain quality and the grain boundary presence. The necessary condition to provide a linear response to the radiation dose-rate absorbed by the detector is correspondent to the condition of high collection efficiency. Once obtained such a condition, the deviation from a correct response can be attributed to space charge effects and to electron-hole recombination mechanisms.

Moreover, some experimental evidences seem to indicate new possible applications of CVD diamond for the realization of *active devices* (conversion of high energy radiation into electrical power) making use of the charging induced by secondary electron emission.

REFERENCES

1. D.M. Trucchi, P. Ascarelli, E.Cappelli, et al., "The Influence of Grain-Boundaries on the Electronic Performance of CVD Diamond Films" *Diam.Relat. Mater.*, accepted for publication (2005).